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Phytochemical profiling of aqueous extract of elephant grass (*Pennisetum purpureum)* using Gas Chromatography–Mass Spectrometry (GC-MS)

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Abstract

Objective: Elephant grass (*Pennisetum purpureum* Schumach) is a monocotyledon belonging to the family Poaceae (grass family). It is an excellent forage in the tropical and subtropical regions and the major livestock feed in West Africa, particularly for cattle, dairy and sheep. In this work, the leaves of *Pennisetum purpureum* (Schumach) commonly called elephant grass, were subjected to phytochemical screening using gas chromatography equipped with mass spectrometry (GC-MS).

Methodology: Aqueous extract of *Pennisetum purpureum* were assessed using gas chromatography equipped with mass spectrometry (GC-MS).

Result: In this study gas chromatography mass spectrometry (GC-MS) analysis revealed the presence of remarkable natural bioactive components in aqueous extract of *Pennisetum purpureum*. The major constituents are 9,12-octadecadienoic acid (linoleic acid) (18.89%), Cis-13-octadecenoic acid (15.74%), 1,2-benzisothiazole (6.69%), 11-octadecenoic acid (5.53%), oleic acid (5.01%). The bioactive components in the aqueous extract of *Pennisetum purpureum* have favourable medicinal characteristics such as anticancer, antioxidant, anti-inflammatory properties and also serve as surfactant, stabilizers, capping and coating agent in nanoparticle synthesis.

Conclusion: The phytochemical profiling of aqueous extract of elephant grass (*Pennisetum purpureum*) using gas chromatography–mass spectrometry (GC-MS) revealed the presence of bioactive compounds with important medicinal properties.

Keywords: *Pennisetum purpureum;* Elephant grass; Phytochemical; Aqueous extract

1. Introduction

Elephant grass (*Pennisetum purpureum* Schumach) is a monocotyledon belonging to the family Poaceae (grass family) and genus *Pennisetum* (Negawo et al., 2017). Elephant grass is a high yielding forage in the tropical and subtropical regions. This plant is the major livestock feed in West Africa, particularly for diary, cattle and sheep (Bakare et al., 2020). Elephant grass can be used as an alternative to other feed options, it requires a minimum amount of inputs and land (Negawo et al., 2017).

Elephant grass is a multipurpose plant, the young leaves and shoots are edible by humans and can be cooked to make stews and soups (Burkill, 1985). Thatch can be made from the whole plant and the culms can be used to make fences.

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Leaf and culm infusions are reported to have diuretic proper. This grass has several environmental applications such as soil erosion control, weed control and phytoremediation studies (Alikasturi et al., 2020).

2. Material and methods

2.1. Collection and Identification of Plant Materials

Fresh leaves of Elephant grass (*Pennisetum purpureum)* were harvested from University of Port Harcourt, Rivers State and was identified and authenticated by a taxonomist Dr. Wisdom Barade (WNB85) in the Department of Science Laboratory Technology at Kenule Beeson Saro-Wiwa Polytechnic, Bori. Rivers State. The voucher number (No. 317) was obtained from Kenule Beeson Saro-Wiwa Polytechnic, Bori. Rivers State herbarium.

2.2. Preparation of Aqueous Extract

The fresh leaves of elephant grass (*Pennisetum purpureum*) were thoroughly washed with clean tap water (2 – 3 times) and then air-dried at room temperature for two weeks. The air-dried leaf sample was pulverized and stored in an air-tight container at room temperature. The pulverized sample (100 g) was mixed with 500 mL of distilled water in a conical flask. This was covered, shaken every 30 minutes for 6 hours and then allowed to stand for about 24 hours. The solution was subsequently shaken and filtered using muslin cloth and refiltered using Whatman number 1 filter paper. The filtrate was evaporated to dryness using a rotary evaporator (Model type 349/2, Corning Ltd). The extract was stored at 4 ^{o}C for further analysis.

2.3. phytochemical studies using GC-MS

The crude aqueous extract of *Pennisetum purpureum* was analysed for the quality and quantity of the volatile phytochemicals present in it using GC-MS technique. The GC-MS was performed on a Thermo Scientific Co, Thermo GC-TRACE Ultra Ver. 5.0, thermo MS DSQ II. Experimental conditions of GC-MS include; BS-MS dimension: 30 Mts, ID: 0.25 mm, Film thickness: 0.25 µm. The flow rate of the mobile phase (carrier gas: helium) was set at 1.0 ml/min. In the gas chromatography part, the temperature program (oven temperature) was initially 40 °C and was raised to 150 °C at 10°C/min. The temperature was again raised to 230 °C/min at the rate 5 °C/min and the process continued till the temperature remained constant at 280 °C at the rate of 20 °C/min which was held for 8 minutes. The injector port temperature remained constant at 280 °C and detector temperature was 250 °C.

The crude extract (1 g) was reconstituted in 1 ml of methanol. Then, 2 µl of the extract was injected into the port and vaporized down the column with helium as the carrier gas at the flow rate of 1 ml/min and the results were compared to Wiley Spectral Library Search Program. Interpretation of the mass spectrum of the constituents of the extract was carried out in comparison with the database of the National Institute of Standard and Technology (NIST).

$$\text{Percentage yield} = (\text{weight of extract} \times 100) / (\text{weight of starting material})$$

3. Results and discussion

Plants in the genus *Pennisetum* have been shown to be active in terms of phytochemicals (as alkaloids, flavonoids, tannins, saponins, polyphenols, and anthraquinones) and pharmacological activities (Brantley, Akaninwor & Achor, 2015).

In this study gas chromatography mass spectrometry (GC-MS) analysis revealed the presence of remarkable natural bioactive components in aqueous extract of *Pennisetum purpureum*. The major constituents are 9,12-octadecadienoic acid (linoleic acid) (18.89 %), Cis-13-octadecenoic acid (15.74 %), 1,2-benzisothiazole (6.69 %), 11-octadecenoic acid (5.53 %) , oleic acid (5.01 %), Hexadecanoic acid (Palmitic acid) (2.40 %), Octadecanoic acid (Stearic acid) (1.45 %). The bioactive components in the aqueous extract of *Pennisetum purpureum* with favourable medicinal characteristics such as anticancer, antioxidant, anti-inflammatory properties and also serve as surfactant, stabilizers, capping and coating agent in nanoparticle synthesis.

Jack et al., (2020) conducted a qualitative screening of phytochemicals on three extracts of *Pennisetum purpureum*; n-hexane (non-polar), ethyl acetate (semi-polar) and methanol (polar). The metabolites included saponins, flavonoids, steroids, terpenoids, alkaloids, and cardiac glycosides after the plant was extracted with methanol and ethyl acetate, but the plant extracted with n-hexane revealed that they are rich in steroids and terpenoids.

Table 1 GC- MS result of phytochemical composition of aqueous extract of *Pennisetum purpureum*

peak #	Retention time	Name of compound	Peak area (%)
1	8.403	Ethyl 9-hexadecenoate	0.03
2	8.740	Oleic acid	0.04
3	9.552	2-methyl-Z,Z-3,13-Octadecadienol	0.04
4	9.713	3, 11- tetradecadien -1-o1	0.05
5	20.225	Hexadecanoic acid	2.40
6	21.578	Hexadecanoic acid	0.42
7	22.015	n- hexadecanoic acid	0.71
8	22.015	n-hexadecanoic acid	0.60
9	22.942	n-hexadecanoic acid	0.03
10	23.336	9,12-octadecadienoic acid (Linoleic acid)	18.89
11	23.467	Cis-13-octadenoic acid 11-octadecenoic acid	15.74
12	24. 0.63	Methyl stearate	1.92
13.	25.249	Cis –vaccenic acid	3.37
14	25.249	Oleic acid Cis vaccenic acid	2.85
15.	25.554	5-eicosene, (E)- 3- Eicosene, (E) 9-Eicosene, (E)-	0.69
16.	25.671	Octadecanoic acid (Stearic acid)	1.45
17.	25.768	Octadecanoic acid	0.65
18	30.854	Docosanoic acid	0.15
19.	30.890	9-eicosenoic acid	0.04
19.	33.891	Eicosyl propyl ether	0.03
20.	34.453	9-octadecenoic acid	0.02
21.	34.492	Oleic acid Cis- vacenic acid	0.01
22.	34.569	Oleic acid	0.02
23.	34.695	Oleic acid	0.03
24.	34.757	13-octadecenal	0.01
25.	34.792	Oleic acid 6-octadecenoic acid	0.01
26.	35.034	2-methyl-Z,Z-3,13- octadecatrienoyl	0.27
27.	35.068	2-methyl-z, z-3, 13-Octadecadienol, Oleic acid	0.11
28.	35.108	Oleic acid 13-octadecenal	0.03

29.	35.130	Oleic acid 9-octadecenoic acid	0.03
30.	35.152	9-octadecenoic acid 5-eicosene	0.01
31.	35.152	Oleic acid Cis -13-octadecenoic acid	0.04
32.	35.384	Oleic acid	0.16
33.	35.448	1,2-benzisothiazole Oleic acid Cis -13-octadecenoic	0.08
34.	35.697	Oleic acid Cis -13-octadecenoic acid Trans-13-octadecenoic acid	0.01
35.	35.831	cis -11-hexadecadien-1-yl Oleic acid	1.16
36.	35.915	2-methyl-z, z-3,13-octadecadienol Oleic acid	1.10
37.	35.945	trans-13-octadecenic acid 3-eicosene	0.46
38.	36.221	1,2benzisothiazole Oleic acid	6.69
39.	36.244	2-Methyl-Z, Z-3,13-Octadienol Oleic acid n-propyl 11-octadecenoate	0.76
40.	36.376	Oleic acid 11-octadecenoic acid	5.53
41.	36.437	Oleic acid	3.84
42.	36.480	Oleic acid 9-Octadecenoic acid	1.78
43.	36.529	Erucic acid Oleic acid	2.19
44.	36.568	Erucic acid Oleic acid	1.72
45	36.637	Oleic acid	2.29
46.	36.657	3-Eicosene, Oleic acid Cis-vaccenic	1.11
47.	36.688	Oleic acid 14-pentadecenoic acid	1.90
48.	36.732	Erucic acid Oleic acid	0.78

49.	36.757	Oleic acid 7,11-hexadecadienal	1.68
50.	36.801	Oleic acid 2-methyl-Z,Z-3,13-octadecadienol	1.26
51.	36.995	Oleic acid Octadec-9-enoic acid	0.55
52.	37.266	Z,Z-3,13-Octadecadien-1-ol Oleic acid	0.04
53.	37.293	cis-11-hexadecadien-1-yl Oleic acid Octadec-9-enoic acid	0.03
54.	37.323	1-Docosene Oleic acid	0.04
55.	37.376	E-9-Tetradecenal Oleic acid	0.07
56.	37.480	Erucic acid Oleic acid	0.78
57.	37.807	Erucic acid Oleic acid	5.01
58.	37.882	Oleic acid 2-methyl-Z,Z-3,13-octadecadienol 9-Eicosenoic acid, (Z)-	1.32
59.	37.948	Z-2-Octadecen-1-ol Oleic acid 1,19-Eicosadiene	2.56
60.	38.015	Oleic acid Oxirane, tetradecyl 9-Octadecenoic acid (Z)-,2,3-dihydroxypropyl ester	2.27
61.	38.122	Oleic acid Erucic acid 3-Eicosene	1.25
62.	38.270	Oleic acid 1,14-Docosanediol 1,19-Eicosadiene	2.47

Table 2 Major phytochemical composition of the aqueous extract of Pennisetum purpureum and its biological activities

Peak #	RETENTION TIME	NAME OF COMPOUND	PEAK AREA (%)	BIOLOGICAL ACTIVITY	REFERENCES
1	23.336	9,12-octadecadienoic acid (Linoleic acid)	18.89	Anti-inflammatory, hypocholesterolemic, cancer preventive, hepatoprotective, nematicide, antihistaminic, antieczemic, antiacne, alpha reductase inhibitor, antiandrogenic, antiarthritic. Serves as surfactant, capping and coating agent in nanoparticle synthesis	Simon et al., 2002 Rotcharin et al., 2019
2	23.467	Cis-13-octadenoic acid 11-octadecenoic acid	15.74	Anti inflammatory properties .Serves as surfactant, capping and coating agent in nanoparticle synthesis	Rotcharin et al., 2019
3	25.249	Cis –vaccenic acid	3.37	Anti inflammatory, antioxidant properties. Serves as surfactant, capping and coating agent in nanoparticle synthesis	Rotcharin et al., 2019
4	36.221	1,2benzisothiazole Oleic acid	6.69	Anti-inflammatory, antimicrobial, anti-oxidant properties. Serves as surfactant, capping and coating agent in nanoparticle synthesis.	Rotcharin et al., 2019
5	36.376	Oleic acid 11-octadecenoic acid	5.53	Anticancer, Antioxidant, Anti-inflammatory, Antimicrobial properties. Serve as surfactant, capping and coating agent in nanoparticle synthesis.	Guadalupe-Medina et al., 2013 Dong et al., 2016
6	36.437	Oleic acid	3.84	Anticancer, Antioxidant, Anti-inflammatory, Antimicrobial properties. Serves as surfactant, capping and coating agent in nanoparticle synthesis.	Guadalupe-Medina et al., 2013. Dong et al., 2016
7	37.807	Erucic acid Oleic acid	5.01	Anticancer, Antioxidant, Anti-inflammatory properties, Serve as surfactant, capping and coating agent in nanoparticle synthesis	Guadalupe-Medina et al., 2013. Dong et al., 2016
8	25.671	Octadecanoic acid (Stearic acid)	1.45	Anti inflammatory, antioxidant properties. Serves as surfactant, capping and coating agent in nanoparticle synthesis	Simon et al., 2022 Rotcharin et al., 2019
9	20.225	Hexadecanoic acid (Palmitic acid)	2.40	Antimicrobial, Anti-inflammatory properties. Coating agent in nanoparticle synthesis.	Rotcharin et al., 2019

4. Conclusion

The phytochemical profiling of aqueous extract of elephant grass (*Pennisetum purpureum*) using gas chromatography–mass spectrometry (GC-MS) revealed the presence of bioactive compounds. The bioactive components in the aqueous

extract of *Pennisetum purpureum* have favourable medicinal characteristics such as anticancer, antioxidant, anti-inflammatory properties and also serve as surfactant, stabilizers, capping and coating agent in nanoparticle synthesis.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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